



**THE DATASHEET OF  
ICS650R-07I**



**NETWORKING CLOCK SOURCE**
**ICS650-07C**
**Description**

The ICS650-07C is a low cost, low jitter, high performance clock synthesizer for networking applications. Using analog Phase-Locked Loop (PLL) techniques, the device accepts a 12.5 MHz or 25.00 MHz clock or fundamental mode crystal input to produce multiple output clocks for networking chips, PCI devices, SDRAM, and ASICs. The ICS650-07C outputs all have 0 ppm synthesis error.

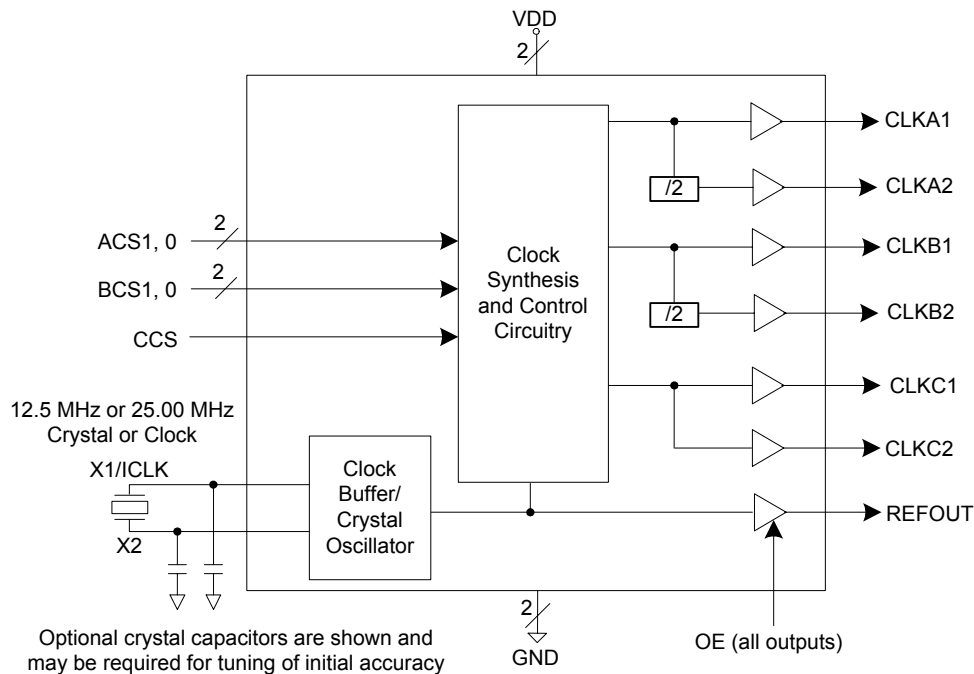
See the MK74CB214, ICS551, and ICS552-01 for non-PLL buffer devices which produce multiple low-skew copies of these output clocks.

See the ICS570, ICS9112-16/17/18 for zero delay buffers that can synchronize outputs and other needed clocks.

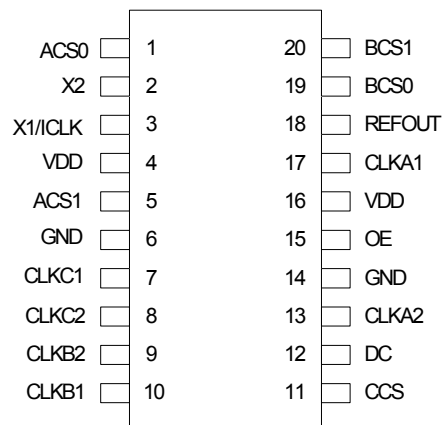
**Features**

- Packaged in 20-pin tiny SSOP (QSOP)
- Available in Pb (lead) free package
- 12.5 MHz or 25.00 MHz fundamental crystal or clock input
- Six output clocks with selectable frequencies
- SDRAM frequencies of 67, 83, 100, and 133 MHz
- Buffered crystal reference output
- Zero ppm synthesis error in all clocks
- Ideal for PMC-Sierra's ATM switch chips
- Full CMOS output swing with 25 mA output drive capability at TTL levels
- Advanced, low power, sub-micron CMOS process
- 3.0 V to 5.5 V operating voltage

**NOTE: EOL for non-green parts to occur on 5/13/10 per PDN U-09-01**

**Block Diagram**


## Pin Assignment



20 pin (150 ml) SSOP

## Pin Descriptions

| Pin | Name    | Pin Type        | Description   |
|-----|---------|-----------------|---|
| 1   | ACS0    | Tri-level Input | A clock select 0. Selects outputs on CLKA1 and CLKA2. See table below.                            |
| 2   | X2      | XO              | Crystal connection. Connect to a crystal or leave unconnected for clock input.                    |
| 3   | X1/ICLK | XI              | Crystal connection. Connect to fundamental crystal or clock input.                                |
| 4   | VDD     | Power           | Connect to 3.3 V or 5 V. Must be same value as other VDD.   |
| 5   | ACS1    | Input           | A clock select 1. Selects outputs on CLKA1 and CLKA2. Internal pull-up resistor. See table below. |
| 6   | GND     | Power           | Connect to ground.  |
| 7   | CLKC1   | Output          | Clock C output 1. Depends on setting of CCS per table below.                                      |
| 8   | CLKC2   | Output          | Clock C output 2. Depends on setting of CCS per table below. Same as CLKC1.                       |
| 9   | CLKB2   | Output          | Clock B output 2. Depends on setting of BCS1, 0 per table below.                                  |
| 10  | CLKB1   | Output          | Clock B output 1. Depends on setting of BCS1, 0 per table below.                                  |
| 11  | CCS     | Tri-level Input | Clock C Select pin. Selects outputs on CLKC1 and CLKC2 per table below.                           |
| 12  | DC      | —               | Don't Connect. Do not connect anything to this pin.   |
| 13  | CLKA2   | Output          | Clock A output 2. Depends on setting of ACS1, 0 per table below.                                  |
| 14  | GND     | Power           | Connect to ground.  |
| 15  | OE      | Input           | Output enable. Tri-states all outputs when low. Internal pull-up resistor.                        |
| 16  | VDD     | Power           | Connect to VDD. Must be same value as other VDD.  |
| 17  | CLKA1   | Output          | Clock A output 1. Depends on setting of ACS1, 0 per table below.                                  |
| 18  | REFOUT  | Output          | Buffered reference clock output. Same frequency as crystal or clock input.                        |
| 19  | BCS0    | Tri-level Input | B clock select 0. Selects outputs on CLKB1 and CLKB2. See table below.                            |
| 20  | BCS1    | Input           | B clock select 1. Selects outputs on CLKB1 and CLKB2. See table below.                            |

For a 25 MHz Fundamental Crystal or Clock Input, use the following tables:

### A Clocks Select Table (MHz)

| ACS1 | ACS0 | CLKA1   | CLKA2     |
|------|------|---------|-----------|
| 0    | 0    | 100     | OFF (low) |
| 0    | M    | TEST    | TEST      |
| 0    | 1    | 75      | OFF (low) |
| 1    | 0    | 33.3333 | 16.6667   |
| 1    | M    | TEST    | TEST      |
| 1    | 1    | 66.6667 | 33.3333   |

### B Clocks Select Table (MHz)

| BCS1 | BCS0 | CLKB1    | CLKB2   |
|------|------|----------|---------|
| 0    | 0    | TEST     | TEST    |
| 0    | M    | 66.6667  | 33.3333 |
| 0    | 1    | 100      | 50      |
| 1    | 0    | 83.3333  | 41.6667 |
| 1    | M    | TEST     | TEST    |
| 1    | 1    | 133.3333 | 66.6667 |

### C Clocks Select Table (MHz)

| CCS | CLKC1 | CLKC2 |
|-----|-------|-------|
| 0   | 125   | 125   |
| M   | TEST  | TEST  |
| 1   | 75    | 75    |

REFOUT = 25 MHz

0 = connect directly to ground

1 = connect directly to VDD

M = leave unconnected (automatically self biases to VDD/2)

For a 12.5 MHz Crystal or Clock Input, use the following tables:

### A Clocks Select Table (MHz)

| ACS1 | ACS0 | CLKA1   | CLKA2     |
|------|------|---------|-----------|
| 0    | 0    | 50      | OFF (low) |
| 0    | M    | TEST    | TEST      |
| 0    | 1    | 37.5    | OFF (low) |
| 1    | 0    | 16.6667 | 8.3333    |
| 1    | M    | TEST    | TEST      |
| 1    | 1    | 33.3333 | 16.6667   |

### B Clocks Select Table (MHz)

| BCS1 | BCS0 | CLKB1    | CLKB2   |
|------|------|----------|---------|
| 0    | 0    | TEST     | TEST    |
| 0    | M    | 33.3333  | 16.6667 |
| 0    | 1    | 50       | 25      |
| 1    | 0    | 41.66667 | 20.8333 |
| 1    | M    | TEST     | TEST    |
| 1    | 1    | 66.6667  | 33.3333 |

### C Clocks Select Table (MHz)

| CCS | CLKC1 | CLKC2 |
|-----|-------|-------|
| 0   | 62.5  | 62.5  |
| M   | TEST  | TEST  |
| 1   | 37.5  | 37.5  |

REFOUT = 12.5 MHz

0 = connect directly to ground

1 = connect directly to VDD

M = leave unconnected (automatically self biases to VDD/2)

## External Components

The ICS650-07C requires a minimum number of external components for proper operation.

### Decoupling Capacitor

Decoupling capacitors of 0.01 $\mu$ F must be connected between each VDD and GND (pins 4 and 6, pins 16 and 14), as close to the device as possible. For optimum device performance, the decoupling capacitor should be mounted on the component side of the PCB. Avoid the use of vias in the decoupling circuit.

### Series Termination Resistor

When the PCB trace between the clock outputs and the loads are over 1 inch, series termination should be used. To series terminate a 50 $\Omega$  trace (a commonly used trace

impedance) place a 33 $\Omega$  resistor in series with the clock line, as close to the clock output pin as possible. The nominal impedance of the clock output is 20 $\Omega$ .

### Crystal Information

The crystal used should be a fundamental mode (do not use third overtone), parallel resonant. Crystal capacitors should be connected from pins X1 to ground and X2 to ground to optimize the initial accuracy. The value of these capacitors is given by the following equation:

$$\text{Crystal caps (pF)} = (C_L - 6) \times 2$$

In the equation,  $C_L$  is the crystal load capacitance. So, for a crystal with a 16 pF load capacitance, two 20 pF capacitors should be used. If a clock input is used, drive it into X1 and leave X2 unconnected.

## Absolute Maximum Ratings

Stresses above the ratings listed below can cause permanent damage to the ICS650-07C. These ratings, which are standard values for IDT commercially rated parts, are stress ratings only. Functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods can affect product reliability. Electrical parameters are guaranteed only over the recommended operating temperature range.

| Item                                       | Rating              |
|--|---------------------|
| Supply Voltage, VDD                        | 7 V                 |
| All Inputs and Outputs                     | -0.5 V to VDD+0.5 V |
| Ambient Operating Temperature (commercial) | 0 to +70° C         |
| Ambient Operating Temperature (industrial) | -40 to +85° C       |
| Storage Temperature                        | -65 to +150° C      |
| Junction Temperature                       | 125° C              |
| Soldering Temperature (20 seconds max)     | 260° C              |

## Recommended Operation Conditions

| Parameter   | Min. | Typ. | Max. | Units |
|---|------|------|------|-------|
| Ambient Operating Temperature (commercial)          | 0    |      | +70  | ° C   |
| Ambient Operating Temperature (industrial)          | -40  |      | +85  | ° C   |
| Power Supply Voltage (measured with respect to GND) | +3.0 | +3.3 | +5.5 | V     |

## DC Electrical Characteristics

Unless stated otherwise, **VDD = 5 V**

| Parameter                 | Symbol          | Conditions                     | Min.    | Typ.  | Max.    | Units |
|---------------------------|-----------------|--------------------------------|---------|-------|---------|-------|
| Operating Voltage         | VDD             |                                | 3.0     |       | 5.5     | V     |
| Supply Current            | IDD             | No load                        |         | 60    |         | mA    |
| Input High Voltage        | V <sub>IH</sub> | X1 pin only, Clock input       | VDD/2+1 | VDD/2 |         | V     |
| Input Low Voltage         | V <sub>IL</sub> | X1 pin only, Clock input       |         | VDD/2 | VDD/2-1 | V     |
| Input High Voltage        | V <sub>IH</sub> | All tri-level inputs           | VDD-0.5 |       |         | V     |
| Input Low Voltage         | V <sub>IL</sub> | All tri-level inputs           |         |       | 0.5     | V     |
| Input High Voltage        | V <sub>IH</sub> | Other inputs, except tri-level | 2       |       |         | V     |
| Input Low Voltage         | V <sub>IL</sub> | Other inputs, except tri-level |         |       | 0.8     | V     |
| Output High Voltage       | V <sub>OH</sub> | I <sub>OH</sub> = -25 mA       | 2.4     |       |         | V     |
| Output High Voltage       | V <sub>OH</sub> | I <sub>OH</sub> = -8 mA        | VDD-0.4 |       |         | V     |
| Output Low Voltage        | V <sub>OL</sub> | I <sub>OL</sub> = 25 mA        |         |       | 0.4     | V     |
| Short Circuit Current     | I <sub>OS</sub> | Each output                    |         | ±100  |         | mA    |
| Internal Pull-up Resistor |                 | ACS1, BCS1, OE                 |         | 200   |         | kΩ    |

## AC Electrical Characteristics

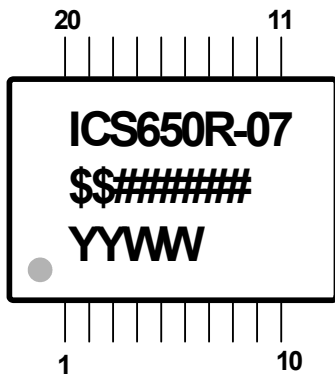
Unless stated otherwise, **VDD = 5 V**

| Parameter                   | Symbol          | Conditions          | Min. | Typ.       | Max. | Units |
|-----------------------------|-----------------|---------------------|------|------------|------|-------|
| Input Frequency             |                 |                     | 10   | 12.5 or 25 | 27   | MHz   |
| Frequency Error             |                 | All clocks          |      |            | 0    | ppm   |
| Output Rise Time            | t <sub>OR</sub> | 0.8 to 2.0 V        |      |            | 1.5  | ns    |
| Output Fall Time            | t <sub>OF</sub> | 2.0 to 0.8 V        |      |            | 1.5  | ns    |
| Output Clock Duty Cycle     |                 | At VDD/2            | 40   | 50         | 60   | %     |
| Absolute Jitter, short term |                 | Variation from mean |      | 150        |      | ps    |

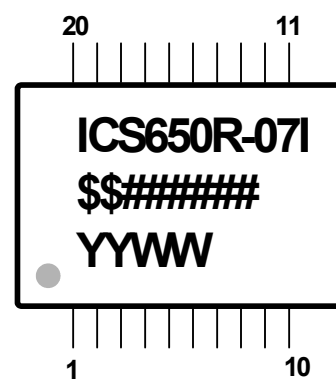
## Thermal Characteristics

| Parameter                              | Symbol        | Conditions     | Min. | Typ. | Max. | Units                |
|--|---------------|----------------|------|------|------|----------------------|
| Thermal Resistance Junction to Ambient | $\theta_{JA}$ | Still air      |      | 135  |      | $^{\circ}\text{C/W}$ |
|  | $\theta_{JA}$ | 1 m/s air flow |      | 93   |      | $^{\circ}\text{C/W}$ |
|  | $\theta_{JA}$ | 3 m/s air flow |      | 78   |      | $^{\circ}\text{C/W}$ |
| Thermal Resistance Junction to Case    | $\theta_{JC}$ |                |      | 60   |      | $^{\circ}\text{C/W}$ |

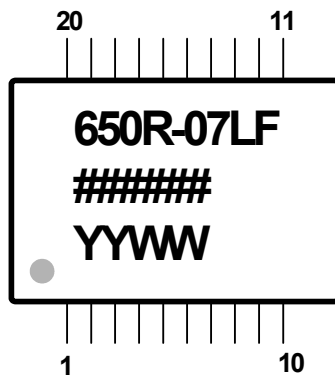
### Marking Diagram—ICS650R-07



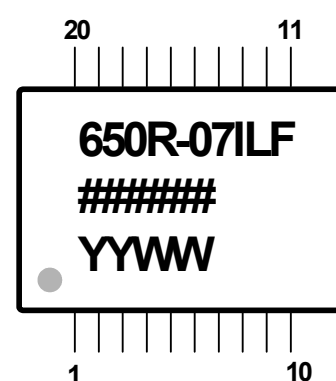
### Marking Diagram—ICS650R-07I



### Marking Diagram—ICS650R-07LF



### Marking Diagram—ICS650R-07ILF

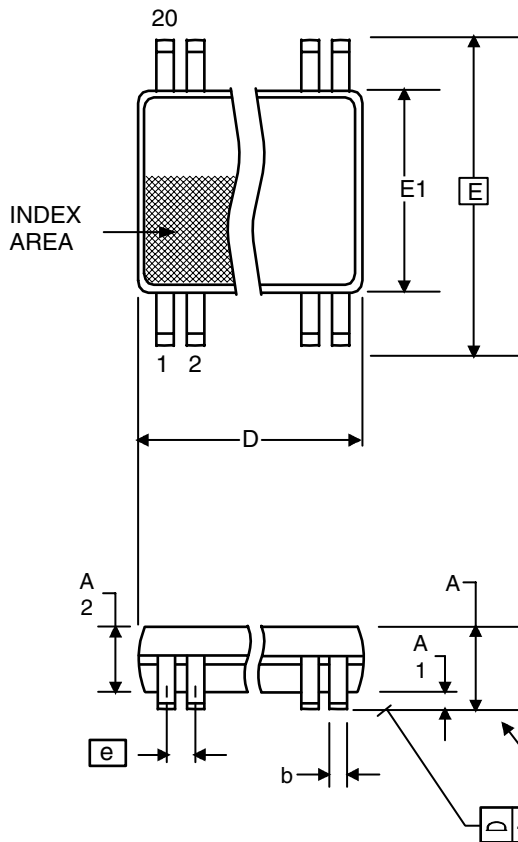


#### Notes:

- ##### is the lot code.
- YYWW is the last two digits of the year, and the week number that the part was assembled.
- “LF” denotes Pb (lead) free package.
- “I” denotes industrial grade device.
- Bottom marking: (origin) = country of origin if not USA.

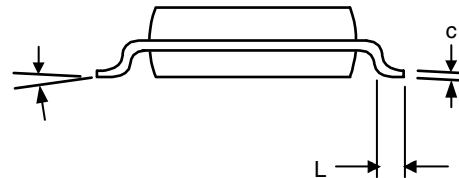
## Package Outline and Package Dimensions (20-pin SSOP, 150 Mil. Body)

Package dimensions are kept current with JEDEC Publication No. 95



| Symbol   | Millimeters |      | Inches*    |       |
|----------|-------------|------|------------|-------|
|          | Min         | Max  | Min        | Max   |
| A        | 1.35        | 1.75 | 0.053      | 0.069 |
| A1       | 0.10        | 0.25 | 0.004      | 0.010 |
| A2       | --          | 1.50 | --         | 0.059 |
| b        | 0.20        | 0.30 | 0.008      | 0.012 |
| c        | 0.18        | 0.25 | 0.007      | 0.010 |
| D        | 8.55        | 8.75 | 0.337      | 0.344 |
| E        | 5.80        | 6.20 | 0.228      | 0.244 |
| E1       | 3.80        | 4.00 | 0.150      | 0.157 |
| e        | .635 Basic  |      | .025 Basic |       |
| L        | 0.40        | 1.27 | 0.016      | 0.050 |
| $\alpha$ | 0°          | 8°   | 0°         | 8°    |

\*For reference only. Controlling dimensions in mm.



## Ordering Information

| Part / Order Number | Marking    | Shipping Packaging | Package     | Temperature   |
|---------------------|------------|--------------------|-------------|---------------|
| 650R-07*            | see page 7 | Tubes              | 20-pin SSOP | 0 to +70° C   |
| 650R-07T*           |            | Tape and Reel      | 20-pin SSOP | 0 to +70° C   |
| 650R-07LF           |            | Tubes              | 20-pin SSOP | 0 to +70° C   |
| 650R-07LFT          |            | Tape and Reel      | 20-pin SSOP | 0 to +70° C   |
| 650R-07I*           |            | Tubes              | 20-pin SSOP | -40 to +85° C |
| 650R-07IT*          |            | Tape and Reel      | 20-pin SSOP | -40 to +85° C |
| 650R-07ILF          |            | Tubes              | 20-pin SSOP | -40 to +85° C |
| 650R-07ILFT         |            | Tape and Reel      | 20-pin SSOP | -40 to +85° C |

\*NOTE: EOL for non-green parts to occur on 5/13/10 per PDN U-09-01

Parts that are ordered with a "LF" suffix to the part number are the Pb-Free configuration and are RoHS compliant.

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